

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6: A61F 13/15, G01R 33/44		(11) International Publication Number: WO 96/12459
		(43) International Publication Date: 2 May 1996 (02.05.96)
<p>(21) International Application Number: PCT/US95/13565</p> <p>(22) International Filing Date: 11 October 1995 (11.10.95)</p> <p>(30) Priority Data: 08/327,945 24 October 1994 (24.10.94) US</p> <p>(71) Applicant: THE DOW CHEMICAL COMPANY (US/US); 2030 Dow Center, Abbott Road, Midland, MI 48640 (US).</p> <p>(72) Inventors: KAR, Kishore, K.; 4616 Oakridge Drive, Midland, MI 48640 (US). THOMAS, Robert, J.; 4907 Grandview Street, Midland, MI 48640 (US). STAPLES, Thomas, L.; 3212 Noeske Street, Midland, MI 48640 (US).</p> <p>(74) Agent: ROBERTS, John, H.; The Dow Chemical Company, Patent Dept., P.O. Box 1967, Midland, MI 48641-1967 (US).</p>		<p>(81) Designated States: BR, CN, JP, KR, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>Without international search report and to be republished upon receipt of that report.</i></p>
<p>(54) Title: ABSORBENT STRUCTURE WITH FLUID-IMPERMEABLE PATCH</p> <p>(57) Abstract</p> <p>This invention relates to an absorbent structure, preferably containing superabsorbent polymer in an absorbent layer, and in particular, to a structure with a centrally located fluid-impermeable patch which redirects an insulating fluid around it in a manner to increase the overall containment efficiency of the structure. The absorbent structure of this invention is suitable for use in various absorbent articles and absorbent devices, such as, for example, disposable diapers, sanitary napkins, incontinent devices and garments, and training garments. The invention also relates to methods to determine the location of moisture within an absorbent structure and to study fluid flow and absorption of aqueous fluid by absorbent structures in real time.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MZ	Mauritania
AU	Australia	GE	Georgia	MW	Mslawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LJ	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

WO 96/12459

PCT/US95/13565.

ABSORBENT STRUCTURE WITH FLUID-IMPERMEABLE PATCH

This invention relates to an absorbent structure, preferably containing superabsorbent polymer, and in particular, to a structure with diversionary means at the central insult site which redirects the insulting fluid in a manner to increase the overall containment efficiency of the structure. The invention also relates to methods to determine the location of moisture within an absorbent structure and to study fluid flow and absorption of aqueous fluid by an absorbent structure in real time.

Absorbent structures are used in absorbent devices for personal use, such as diapers, sanitary napkins, incontinent devices and garments, training pants, and in other applications, such as surgical or medicinal absorbent pads or drapes, bed pads and cable shielding. The incorporation of superabsorbent polymers in an absorbent structure greatly increases the absorbing power of the structure.

However, depending upon the device or garment in which the structure is used and the nature of the insult to which the structure is subjected, little of the absorbing power of the superabsorbent polymers in the structure may be effectively utilized. When there is a localized insult wherein the insulting fluid impinges upon a relatively small area of the absorbent structure at a rapid rate, such as, for example, when a baby urinates in a diaper, the insulted area of the structure may be initially overwhelmed. Thus, a basic problem requiring a solution in the field of absorbent structure design is the rapid absorption of a localized insult and distribution of the insulting fluid through the structure so that it can be effectively absorbed by the superabsorbent polymer.

U. S. Patent No. 4,880,419 discusses the problems of distribution and containment of the superabsorbent polymer within the absorbent structure, and the problems of gel blocking and lack of wicking of the polymer itself. The patent discloses an absorbent article which has discrete superabsorbent containing layers and wicking means which is wound about and between the superabsorbent containing layers.

U. S. Patent No. 4,973,325 discusses fluid handling problems encountered in the use of several absorbent structure containing devices and discloses an absorbent article containing a pair of absorbents positioned adjacent to each other. The article has a coaxially aligned transfer member for facilitating movement of body fluid from the cover downward and outward to distant areas of absorbent.

U. S. Patent No. 5,151,091 discusses fluid handling problems that may result from the greater longitudinal dimension of various personal absorbent products. The patent discloses an absorbent product having means to direct the fluid flow substantially along the longitudinal direction of the product and substantially limit transverse flow which can result in side failures.

PCT/US95/13565

WO 96/12459

U. S. Patent No. 4,778,459 discloses a disposable diaper which contains an expanse of impermeable material including a channel for guiding urine to an island of absorbent material.

5 U. S. Patent No. 3,927,673 discloses an absorbent article for diapers which has a water impervious interlayer sheet with a plurality of small holes therethrough disposed between the top sheet and the absorbent pad.

U. S. Patent No. 3,934,588 discloses a disposable diaper structure with facing layers having areas of preferential flow made by variations in the thickness of the material.

10 U. S. Patent No. 4,699,619 discloses an absorbent structure which employs cellulose layers of differing density and pore size to control fluid flow by wicking.

The prior art has recognized the problems of directing the flow of the insulting fluid away from the immediate insult site to structural areas of high absorbency, and various designs have been proposed with structural elements to accomplish this end. However, most of the actual measurements made on absorbent devices report only the overall characteristics of 15 the device. Few attempts have been made to correlate actual functional workings of a device with the theoretical design of the absorbent structure.

U. S. Patent No.'s 4,699,619 and 5,176,668 disclose methods by which it was attempted to verify that the structural elements of the device actually work in the way they were designed to work by measuring the distribution of fluid in the structure after insult. This 20 was done by cutting, weighing, drying and weighing again various sections of the structure to determine fluid distribution.

It would be advantageous to have available a more effective absorbent structure for use in absorbent articles which has means for distribution of fluid insults and more efficient absorption thereof. Further, it would be useful to have an analytical method for observing 25 fluid distribution within the structure, especially a rapid method allowing real time observation of fluid flow.

In one embodiment the invention relates to an absorbent structure comprising:

- (A) an absorbent layer having dimensions of length, width and thickness, the absorbent layer having at least an upper surface with dimensions of length and width, wherein the ratio of length to thickness is from 1 to 1000 and the ratio of width to thickness is from 1 to 500; and
- (B) a fluid-impermeable patch centrally located adjacent to or covering a part of the upper surface of the absorbent layer, the area of the patch being from 2 to 90 percent of the area of the upper surface of the absorbent layer.

30

35

In another embodiment the invention relates to an absorbent structure comprising:

PCT/US95/13565

WO 96/12459

- (A) an absorbent layer having dimensions of length, width and thickness, the absorbent layer having at least an upper surface with dimensions of length and width, wherein the ratio of length to thickness is from 1 to 1000 and the ratio of width to thickness is from 1 to 500;
- 5 (B) a fluid-permeable layer adjacent to the upper surface of the absorbent layer; and
- (C) a fluid-impermeable patch centrally located on a part of at least one surface of the fluid-permeable layer, the area of the patch being from 2 to 90 percent of the area of the upper surface of the absorbent layer.

10 The absorbent structure of this invention is suitable for use in various absorbent articles and absorbent devices, such as, for example, disposable diapers, sanitary napkins, incontinent devices and garments, and training garments. Depending upon the requirements of the device or garment in which the absorbent structure is used, the absorbent structure may be produced in a wide variety of sizes and shapes. For the most effective use of the absorbent 15 structure of this invention, the absorbent structure should be positioned in the device or garment in which it is used with the fluid-impermeable patch between the absorbent layer and the anticipated source of the fluid insult for which the device or garment is designed.

In another embodiment this invention relates to a method for determining the location of aqueous fluid within an absorbent structure with the use of magnetic resonance 20 imaging comprising the steps of:

- (A) performing a magnetic resonance imaging scan on the absorbent structure;
- (B) collecting and storing data from the magnetic resonance imaging scan;
- (C) visually displaying the data.

Magnetic resonance imaging (MRI) is used in the analytical method of this 25 invention to study the location of aqueous fluids absorbed in absorbent structures in three dimensional space without mechanically impacting the structures. Because of the rapidity of the method, fluid flow can be observed in real time, and the effects of multiple fluid insults upon an absorbent structure can be observed sequentially.

FIG. 1 is a schematic of the experimental layout.

30 FIG. 2 is a view showing the scanning protocols used for MRI scanning of absorbent structures.

FIG. 3A is a contour plot of a coronal scan.

FIG. 3B is a surface plot B of a coronal scan.

FIG. 4 is a graphic illustration of data for total signal versus volume of insulting 35 fluid.

FIG. 5A is a screen image from an MRI scan of a transverse slice of an absorbent structure.

FIG. 5B is a surface plot corresponding to FIG. 5A.

WO 96/12459

PCT/US95/13565

FIG. 5C is a profile of the maxima of moisture content corresponding to FIG. 5A and FIG. 5B.

FIG. 6A is a series of profile plots showing fluid movement over time for a first fluid insult.

5 FIG. 6B is a series of profile plots showing fluid movement over time for a second fluid insult.

FIG. 6C is a series of profile plots showing fluid movement over time for a third fluid insult.

10 FIG. 7A is a surface plot for the first fluid insults to an absorbent structure.

FIG. 7B is a surface plot for the second successive fluid insult to an absorbent 15 structure.

FIG. 7C is a surface plot for the third successive fluid insult to an absorbent structure.

20 FIG. 8A is a side view of contour lines of various relative moisture contents in an absorbent structure without a fluid-impermeable patch after a first fluid insult as measured by MRI.

FIG. 8B is a side view of contour lines of various relative moisture contents in an absorbent structure without a fluid-impermeable patch after a second fluid insult as measured by MRI.

25 FIG. 8C is a side view of contour lines of various relative moisture contents in an absorbent structure without a fluid-impermeable patch after a third fluid insult as measured by MRI.

FIG. 8D is a side view of contour lines of various relative moisture contents in an absorbent structure with a fluid-impermeable patch after a first fluid insult as measured by 30 MRI.

FIG. 8E is a side view of contour lines of various relative moisture contents in an absorbent structure with a fluid-impermeable patch after a second fluid insult as measured by MRI.

35 FIG. 8F is a side view of contour lines of various relative moisture contents in an absorbent structure with a fluid-impermeable patch after a third fluid insult as measured by MRI.

The absorbent structure comprises an absorbent layer whose primary function is to absorb fluid insults to the structure. The absorbent layer desirably is composed of fluff or a blend of fluff and superabsorbent polymer. The fluff may generally be one or more of a number of fibrous, fiber-containing or non-fibrous materials which are themselves high in fluid absorption capacity. Desirable materials for fluff include, for example, cotton linters and comminuted wood pulp. A preferred type of fluff is comminuted wood pulp.

PCT/US95/13565

WO 96/12459

Alternatively, the absorbent layer may be composed primarily of or consist essentially of superabsorbent polymer. In this embodiment, superabsorbent polymer is present in one or more alternative forms including woven or nonwoven fibers, fabric, particles, powder or a sheet.

5 In a combination of fluff with superabsorbent polymer, the fluff functions to provide containment means for the superabsorbent polymer particles. The fluff also functions to provide rapid initial absorption of fluid insults with subsequent transport of the fluid to the superabsorbent polymer. The superabsorbent polymer may be in the form of a powder or small particles, fibers, film or a combination thereof. Where the absorbent layer is composed 10 primarily of superabsorbent polymer in various forms, the functions discussed above for fluff can be performed by one or more of the various superabsorbent polymer forms.

Desirably, the absorbent layer of an absorbent structure contains at least 0.1 gram 15 of superabsorbent polymer, preferably at least 1 gram and more preferably 3 grams or more of superabsorbent polymer. While a high superabsorbent polymer content is primarily a matter of cost, desirably the absorbent layer of an absorbent structure contains less than 1 kg, preferably less than 100 grams and more preferably 15 grams or less of superabsorbent polymer.

The fluff used may be a blend of fluff with modified cellulose, other cellulosic materials, or other synthetic materials. Desirable materials include meltblown synthetic fibers 20 and meltblown synthetic fibers containing fluff. Particularly desirable are combinations with superabsorbent polymer. Desirable synthetic materials include, for example, polyethylene, polypropylene, polyesters, polyamides, copolymers of polyesters and polyamides and bicomponent fibers. Modified cellulose fibers include those produced to have high wet stiffness.

25 Alternative forms for the absorbent layer include a laminate consisting of an absorbent film with cellulose tissue on one or both sides. Other desirable forms include an open cell foam, an open cell foam in combination with fluff and/or superabsorbent polymer. Cellulose or synthetic fiber tissue may be wrapped or woven around or within the absorbent 30 layer. The layer may be of varying density, thickness and composition to control liquid holding capacity and liquid distribution.

A wide variety of superabsorbent polymers may be used in the absorbent layer, such as, for example, those disclosed and described in U.S. Patent No.'s 5,075,344; 5,064,582; 35 5,045,614; 4,861,849; 4,833,222; 4,833,198; 4,708,997; 4,666,983; 4,734,478; 4,857,610; 4,605,401; 5,145,906; 5,322,896; 4,541,871; 4,808,637; 4,812,486; RE 32,649; 4,286,082; 5,280,079; 5,280,078; 5,281,673; 5,281,683; 5,241,009; 5,284,936; 5,286,827; 5,281,683; 5,124,188; 5,002,986; 5,102,597 and 4,043,952.

The overall dimensions of the absorbent structure of this invention can vary greatly, depending upon the materials of construction and the particular use for which the

WO 96/12459

PCT/US95/13565

structure is intended. Usually, the absorbent layer has basically the same length and width as the overall absorbent structure. In alternative embodiments, the absorbent layer may have an upper surface area which is from 35 to 99 percent of the area of the absorbent structure.

When incorporated into some common absorbent devices, such as, for example,

- 5 disposable diapers, incontinent devices or garments and training pants, the length of the absorbent layer desirably is from 5 cm to 100 cm, preferably from 10 cm to 75 cm, and more preferably from 20 cm to 50 cm. The width desirably is from 2 cm to 30 cm, preferably from 4 cm to 20, and more preferably from 7 cm to 15 cm. The thickness of the absorbent layer desirably is from 0.1 cm to 5 cm, preferably from .15 cm to 2.5 cm, and more preferably from 0.2 cm to 1.2 cm.

The fluid-permeable layer is permeable to insulting fluid liquids, primarily aqueous liquids, having dissolved or suspended therein a wide variety of inorganic and organic materials. Among the more challenging fluid insults are those of biological origin, such as, for example, urine and blood. Preferred materials for the fluid-permeable layer include, for example, airlaid or meltblown synthetic fibers, which may be bonded or partially bonded thermally or, for example, with latex adhesive. Synthetic polymeric materials for use in the fluid-permeable layer include, for example, rayon, polyester, polyethylene and polypropylene.

Usually, the fluid-permeable layer has basically the same length and width as the overall absorbent structure, or at least the same length and width as the overall absorbent layer. In alternative embodiments, the fluid-permeable layer may have a surface area which is from 35 percent to 350 percent of the area of the absorbent structure, or the absorbent layer.

The fluid-impermeable patch desirably is in the form of a film, and may be produced from any of the aforementioned synthetic and natural materials. In a preferred embodiment the patch is a thermoplastic film produced from a thermoplastic resin. Alternatively, the patch may be in the form of a tightly woven cloth produced from natural or synthetic fibers including synthetic polymer fibers. The film or cloth should be fluid-impermeable, that is, it should not absorb or pass a significant amount of fluid liquid insults and should substantially block the passage of fluid liquid insults.

The area of the fluid-impermeable patch is less than the surface area of the fluid-permeable layer, if present, and the underlying upper surface of the absorbent layer. Desirably, the area of the fluid-impermeable patch is from 2 to 90 percent of the area of the fluid-permeable layer or the absorbent layer, preferably from 5 to 70 percent, more preferably from 10 to 50 percent and still more preferably from 20 to 40 percent.

When incorporated into some common absorbent devices, such as, for example, disposable diapers, incontinent devices or garments and training pants, the length of the fluid-impermeable patch desirably is from 3 cm to 90 cm, preferably from 5 cm to 60 cm, and more preferably from 10 cm to 40 cm. The width desirably is from 1 cm to 25 cm, preferably from 2 cm to 18, and more preferably from 4 cm to 12 cm. The thickness of the fluid-impermeable

WO 96/12459

PCT/US95/13565

patch desirably is from 1 μm to 300 μm , preferably from 5 μm to 200 μm , and more preferably from 10 μm to 75 μm .

- In an embodiment wherein the upper surface of the absorbent layer is adjacent to, covered with or in contact with a fluid-permeable layer, the fluid-impermeable patch is present on at least one of the two surfaces of the fluid-permeable layer. It may be positioned on the surface next to the upper surface of the absorbent layer so that the patch is between the fluid-permeable layer and the upper surface of the absorbent layer. Or it may be positioned on the outer surface of the fluid-permeable layer, in which case the fluid-permeable layer is between the patch and the absorbent layer.

- 10 In an alternative embodiment the patch may be produced on the target area of an absorbent structure by imprinting or embossing the target area of the existing structure with a plastic or resinous material to render it fluid-impermeable. When produced in this way and used with a fluid-permeable layer, the fluid-impermeable aspect of the patch may be present on both surfaces of the fluid-permeable layer, as well as throughout it. Alternatively, if 15 the structure contains no separately definable fluid-permeable layer, the imprinting or embossing may be done directly upon the absorbent layer.

Generally, the dimensions of the fluid-permeable layer are the same as the overall absorbent structure. Often this is the layer which is in contact with the wearer of a personal care device or garment within which the absorbent structure is incorporated. There is a wide 20 range of suitable thicknesses for the fluid-permeable layer, depending upon the materials of construction and amount of compression within the device or garment. Generally, the thickness of the fluid-permeable layer will range from 0.2 mm to 10 mm.

While some insults may be of a gradual or semi-continuous nature, others which are particularly problematical are those resulting from a rapid physiological discharge of a fluid 25 of biological origin, such as, for example, urination or the hemorrhaging of blood. In this context, fluid-impermeable is defined as absorbing or passing less than 5 percent of a fluid insult within 5 minutes of the onset of the insult. Assuming some motivating force, such as, for example, gravity, hydraulic pressure or hydrostatic pressure, greater than 95 percent of the fluid insult is diverted from the insult point on the fluid-impermeable patch and along the 30 surface of the patch to its edge, where it is directed to the fluid-permeable layer for transmission to the absorbent layer.

With a rapid insult of fluid on the fluid-impermeable patch, the effect of the patch is to spread the flow of the insulting stream over a larger area of the absorbent structure by diverting it to the edges of the patch. Thus, soon after initial contact with the absorbent 35 structure, a relatively large total area of the fluid-permeable layer and the absorbent layer are contacted with the insulting stream. Any given local area of the absorbent layer of the structure is contacted by only part of the impinging stream, and, thus, is less likely to be overwhelmed and saturated than if assaulted directly by the total insult. Even if the insult only

WO 96/12459

PCT/US95/13565.

partially impinges upon the fluid-impermeable patch, at least some of the insulting fluid is directed to an area of the fluid-permeable layer and the absorbent layer which otherwise would not be an initial point of contact.

- That part of the absorbent layer which is under the patch is not wasted. Fluid
- 5 which has been diverted by the patch to the edges thereof before coming in contact with the absorbent layer can spread outward toward the extremities of the absorbent structure, and it can also spread inward, under the patch. The overall efficiency of utilization of the absorbent layer and the materials therein is, thus, increased.

- The diversionary action of the fluid-impermeable patch, as described above, has
- 10 the effect of increasing the total area of the fluid-permeable layer and the absorbent layer subject to initial contact with the insulting fluid in comparison to a structure with no patch. Depending upon the motivational force behind the insult this can be very rapid, as would be observed, for example, when saline solution is poured onto a solid surface of some solid material, such as the top of a table. With a larger percentage of the absorbent layer subject to
- 15 initial insult, and a smaller percentage of the total insulting fluid impinging upon any given area of the absorbent layer, secondary problems in absorbent structures, such as gel blocking and the necessity of transport away from the insult site through, for example, wicking, are considerably reduced. The result is a more efficient use of the absorbent materials in the absorbent layer.

- 20 In view of the above described aspects of the absorbent structure of this invention, for use in various absorbent devices and garments, the absorbent structure should be positioned therein so that the fluid-impermeable patch is between the anticipated source of the insult and the absorbent layer of the structure. In addition to varying the general location of the absorbent structure within the device or garment as needed, the size and shape of the
- 25 fluid-impermeable patch can be varied, as well as the percentage of the area of the upper surface of the absorbent layer which is shielded by the patch. Any suitable shape for the patch may be used, such as, for example, square, rectangular, triangular, round or oval, or a more complex shape comprised of various parts of, or combinations of, the basic shapes. This aspect of the absorbent structure may be varied as needed and as appropriate for the device or
- 30 garment in which the absorbent structure is used.

- When the absorbent structure of this invention is used in an absorbent device or garment, the device or garment may include various other layers or other structural elements in combination with the absorbent structure, such as, for example, those disclosed in U.S. Patents Nos. 5,261,899; 5,258,221; 5,171,236; 5,234,422; 5,098,422; 5,135,522; 4,904,249; 4,834,739; 35 4,944,735; 5,180,622; 5,264,082; 5,149,335; 5,149,334; 5,124,188 and 5,260,345; 5,268,224; 5,200,248; 5,190,563 and 5,061,259.

WO 96/12459

PCT/US95/13565

MRI of Absorbent Structures

Nuclear magnetic resonance (NMR) spectroscopy is an analytical technique that allows one to obtain a characteristic spectrum of complex components in mixtures. The signal one sees in NMR is proportional to the number of particular atoms in the sample. The most common atom to observe in NMR is hydrogen.

The extension of NMR to medicine is the technique of magnetic resonance imaging (MRI). A typical MRI instrument uses nuclear magnetic resonance to see the hydrogens on water, the most prevalent chemical in the body. With MRI one can obtain a three dimensional map of water in the body. Instruments in use today use "computer aided tomography" (CAT) to view a slice of the body in any of the three orthogonal planes. This concept, based on constructing a real time image of a planar slice focused in the third dimension, remains the same when adapted to the study of absorbent structures. We have used this technique to look at a flowing saline solution in a fiber matrix of an absorbent structure.

This work was done using a Siemens MAGNETOM™ SP/4000 magnetic resonance imager operating at 1 tesla of magnetic flux density and a frequency of 42 MHz to detect protons. The instrument was operated by Regional Imaging Center located in Auburn, Michigan. Various slices of the sample were scanned; the output was a map of signal intensities from the volume elements in the plane of the scan. A monochrome image of the scanned section was visible on a screen to guide experimental efforts.

The resolution of the signal, that is, the dimensions of the volume element, can be modulated by the settings of the instrument. The time required to collect a signal from a particular location is one of these settings, and therefore one must compromise among the speed of data collection, the precision of the map of moisture content, which is related to pixel size, and the size of the region of interest. These signal intensities can be related to the concentrations of water at these various locations by comparison with the signal from liquid water and the baseline signal from air.

For studies of single or multiple insults by aqueous fluids to absorbent structures containing various structural elements, including superabsorbent polymers, any possible signal contribution from the structural elements of the absorbent structure itself can be corrected for or subtracted from the signal after insult. Usually these baseline contributions are very small or negligible. This versatility in handling the collected data can be used to study the effect of multiple insults on an absorbent structure. For example, after an absorbent structure has become relatively stable following one or more initial insults, a subsequent insult to the structure may be observed. The distribution of the additional moisture content from the subsequent insult along with any redistribution of the moisture content due to the initial insult can be determined by subtracting the signal observed prior to the subsequent insult from the signal observed after the subsequent insult.

WO 96/12459

PCT/US95/13565

For each run in these experiments 11 files of 128 x 128 pixels and 32 files of 256 x 256 pixels were stored, as well as numerous values specifying the conditions of the scans. Each pad configuration generated over 6 megabytes of data. Following the generation and storage of this data, the method involves using means for data transfer, means for decoding, and means for visualization and display.

In order to fix the specimens in the MRI unit a holding device was machined from cast polymethyl-methacrylate, a transparent plastic. Plastic was necessary because most other materials would either absorb radiation or be affected by the intense magnetic field. By relying on gravity the maximum load that could be applied to the sample was the 1.8 kPa (0.25 psi) due to the weight of the solid plastic block. The dimensions of the coil limited the size of the holding assembly, and denser solid materials, such as metals, could not be used. Higher loads can be applied to the absorbent structure by mechanical means, such as hydraulic pressure.

FIG. 1 is a schematic of the experimental layout. The holding device is shown with the plastic block 12 over the absorbent structure 11, also referred to herein as a pad. The insult to the absorbent structure is introduced through a flexible plastic tube 13. For the experiment, an absorbent structure was fitted into this holding device and the entire assembly was set into the head coil 14 of the MRI instrument. The head coil 14 is surrounded by the magnet 15.

The specimen was aligned with two laser beams indicating the center of the magnetic field. The fluid insult was introduced into the sample by a hand-operated syringe connected by a flexible plastic tube to the vertical delivery tube machined from the plastic block. In these runs, 25 mL of fluid was delivered in 1-2 seconds. The fluid supply and syringe operator were positioned approximately 5 meters (15 ft) from the sample to avoid the strong magnetic field around the detector. The long flexible plastic delivery tube which connected the syringe to the sample was filled with fluid before the experiments were begun. The fluid used was 0.9 weight percent aqueous NaCl solution.

In some pads (absorbent structures) a fluid-impermeable patch was placed in the middle of the top surface immediately under the tissue layer. In other pads the patch was omitted. The pad was covered with liner material just before testing. The method of this invention, as used in this study, is useful in determining the effect of structural elements, such as, for example, the fluid-impermeable patch on the flow pattern and ultimate distribution of the fluid insult upon the absorbent structure.

The insult was monitored with one-second scans of the center section of the sample made at one-second intervals. The scanned section was approximately 1 cm thick. FIG. 2 shows the first plane scanned, which is termed the "transverse" plane 22. Thus, a transverse scan is a scan in the transverse plane. FIG. 2 shows the plastic block 12, the absorbent structure 11 and the wetted region 21 of the absorbent structure 11, the wetting due to the insult.

WO 96/12459

PCT/US95/13565

After ten scans at a total elapsed time from the time of the insult of 20 seconds, no further rapid change in the images was observable. A scan in the "coronal" plane 23, known as a coronal scan, was then done. FIG. 2 shows a view of a coronal plane 23 below the plane of the absorbent structure 11 for clarity of illustration. Of course, the actual coronal scan 5 was performed in the coronal plane which contains the absorbent structure 11.

For the coronal scan the thickness of the scanned planar region was intentionally set to include the entire pad. This integrated signal intensity reflects the total relative moisture content through the thickness of the pad.

The coronal scan was followed with 32 high resolution transverse scans 10 "stepping" through the sample from back to front with slices of less than a centimeter in thickness. These are similar to the initial high speed transverse scans of the center slice, but the resolution in the two scanned dimensions is much better because the scan time is longer.

The images observed on the screen during the experiments, which are maps of the intensity obtained from each of the three scanning protocols, provide only gross 15 information. Nevertheless, individual layers of fluff can be observed in high resolution scans with scan times of 16 seconds. The rapid scans of 1 second yield an image that is lower in contrast and more diffuse.

While gross information can be gained from the screen images, precise quantification requires numerical values for the signal strengths at each location. The collected 20 data for the signal strength at each location were transferred to a data file of a VAX™ computer (Trademark of Digital Equipment Corporation, DEC) with the cooperation of both the Siemens Company and Digital Equipment Corporation. It was then possible to manipulate the signal values for each pixel for each scan of each run with computer programs for analysis and visualization of the data that allowed precise comparisons of moisture contents.

FIG. 3A is a typical contour plot of the coronal image. The contours represent 25 various relative moisture contents accumulated through the whole thickness at each position across the span after 24 mL of 0.9 weight percent saline solution has been introduced into the center. A different representation of the same data can be seen in a surface plot as shown in FIG. 3B. The data for FIG. 3A and FIG. 3B are the same, that is, the signal strength is summed 30 over the whole thickness as a function of the two "flat" dimensions of the sample.

Integration of the relative moisture values over the whole extent of the pad should be the equivalent of the 25 mL of the insult. FIG. 4 shows a plot of the total signal from 35 these coronal images after each insult for a particular series of experiments, one of which is shown with circles, the other with boxes. Deviations from zero intercept are due to inconsistent filling and draining of portions of the fluid delivery line. An improvement of the apparatus would include positive shutoff of flow after the insult to prevent this problem.

FIG. 5A shows a view of a typical monochrome image as it would be viewed on the screen of a high speed scan of a transverse slice showing fluid coming into the absorbent

WO 96/12459

PCT/US95/13563

structure 11, here represented by the dashed outline, from the top. The top of FIG. 5A corresponds to the upper part of the plastic block. FIG. 5B is a surface plot of the relative signal intensity inside the solid outline of FIG. 5A. The arrow 51 in FIG. 5B indicates a viewing angle of this surface. FIG. 5C is the profile of maxima of moisture content as viewed from arrow 51 and oriented as in reality with the top of the image corresponding to the upper part of the plastic block. The large spike near the bottom of the profile corresponds to the wetness of the upper surface of the absorbent structure at the instant an image is taken. In this particular image taken at the initial moment of insult, the fluid is moving down the delivery tube and wetting the top surface of the pad before penetrating it. The peaks above the large spike are the result of this fluid in the delivery tube.

FIG.s 6A, 6B and 6C show a series of similar profile plots showing the maximum moisture content viewed across the center line of the absorbent structure for every two seconds during three fluid insults. Keeping in mind that the insult is administered by a hand operated syringe at a distance of 5 meters, the scans at 0 and 2 seconds in FIG. 6A are basically the same flat baseline. The scan at 4 seconds shows some fluid near the top, and the scan at 6 seconds corresponds to the major portion of the insult flowing through the flexible tube and arriving at the upper surface of the absorbent structure. Little fluid movement occurs after the driving pressure of the hand operated syringe stops.

In the FIG. 6B series of scans, the profile view of the baseline scan at 0 seconds shows a large broad peak near the bottom which corresponds to the absorbed fluid from the first insult. Similarly, the large broad peak near the bottom of the baseline scan at 0 seconds of FIG. 6C corresponds to the absorbed fluid from the first and second insults.

Another indication of the relatively small amount of capillary flow, that is, wicking, is the sharp gradient seen in the surface plots from the coronal views. In FIG.s 7A, FIG. 7B and FIG. 7C are presented three surface plots from three successive insults on the same scale. Note the flat tops all coming to the same height. This represents saturation, and subsequent insults simply make the saturated region bigger. In general, we have either saturated plateau or unsaturated plains regions; there is not much intermediate "damp" area.

To demonstrate the effect of a deflector region, that is, a fluid-impermeable patch placed near the target area of an absorbent structure, the profiles of relative moisture content at a series of positions for two different absorbent structures, one with a fluid-impermeable patch and one without a fluid-impermeable patch, were compared. FIG.s 8A-8F illustrate the distribution of three 25 mL insults of saline solution in pads with and without a fluid-impermeable patch. These curves represent vertical sections through surface plots similar to those in FIG.s 7A-C.

Without a patch, FIG. 8A, the fluid was distributed over a radially symmetrical area approximately 5 cm (2 inches) in diameter; the average fluid concentration in this region is approximately 450 units, corresponding essentially to saturation. With a 5 cm (2 x 2 inch) patch,

WO 96/12459

PCT/US95/13565

FIG. 8D, the same amount of fluid is distributed over a toroidally-shaped region approximately 7.5 cm (3 inches) in diameter with a 2.5 cm (one inch) diameter drier region in the middle. The average fluid concentration in the ring of wetness was only about 150 units with peaks around 300 units.

5 The effects of two additional insults on each pad, up to a total of 75 mL in each, are shown in subsequent plots, FIG. 8B and FIG. 8C without the patch, and FIG. 8E and FIG. 8F with the patch. Even after three insults to the absorbent structures, which simulate diapers, the sample with the patch does not have such a well developed "plateau" of saturation as indicated for the control. This quantifies what a user of a diaper containing such an absorbent 10 structure would experience as a drier, more comfortable feel. Using a deflector region allows utilization of more of the core, and, hence, improves efficiency.

Examination of the test samples showed the diaper pad without the patch to be wet on both its surfaces and the pad with the patch to have the fluid more uniformly distributed and much less wet on its surfaces. Both of these absorbent structures were 15 constructed with a polypropylene nonwoven on the upper surface, which was insulted. An additional example utilizing no nonwoven material but with the patch showed intermediate performance.

The deflector patch led to more efficient distribution of the fluid over a larger portion of the pad. Modification of this configuration with respect to shape, relative size, 20 placement, and permeability can be envisioned.

This technique showed the surprising result of how little natural wicking occurred in these experiments. By directly observing the fluid in real time the question of whether the analysis technique affects the result, as would be the case with cutting and weighing, can be eliminated. Of course wicking occurs under some conditions, such as higher loads which 25 compress the pads to a greater extent creating smaller diameter capillaries with higher capillary pressures.

Another major interest is what is the effect of superabsorbents and further, the effect of differences in superabsorbents. Ascertaining the correlation of superabsorbent properties with fluid distribution has in the past been very difficult. This technique simplifies 30 this correlation.

This technique provides a map of water concentration in three dimensional space as a function of time.

Examples of the Absorbent structure

Absorbent structures consisting of composite pads prepared by standard 35 techniques were used to simulate the central portion of a larger absorbent structure, such as that typically found in a diaper. Cellulose fluff was disintegrated with compressed air and layered onto tissue forming 35.6 x 35.6 cm (14 x 14 inch) pads, which were then covered with tissue and then pressed to 1.25 cm (1/2 inch) thickness. Four 15 x 15 cm (6 x 6 inch) samples

WO 96/12459

PCT/US95/13565

weighing 28 to 31 grams were cut from the larger pads and stored at 1.25 cm (1/2 inch) thickness in a constant temperature and humidity room at 21°C (70°F), 50 percent relative humidity, until used.

5 In some pads a fluid-impermeable patch was placed in the middle of the top surface immediately under the tissue layer right after the compression step. In other pads the patch was omitted.

A pad was fitted into a holding device and the entire assembly was set into the head coil of a Siemens MAGNETOM SP/4000 magnetic resonance imager (operating at 1 tesla, 42 MHz proton), commonly used for medical diagnosis, so that magnetic resonance imaging (MRI) could be performed on the absorbent structure. This instrument allows the determination of the signal strength at any location within the sample. This signal can be used to determine the concentration of water at these various locations by comparison with the signal from liquid water and the baseline signal from air. The output from the instrument is a map of the signal intensities from a set of volume elements distributed throughout the selected 10 sets of the three dimensions of the sample pad. The resolution of the signal, that is, the dimensions of the volume element can be modulated by the settings of the instrument. The time required to collect a signal from a particular location is one of these settings, and therefore one must compromise among the speed of data collection, the size of the sample, 15 and the precision of the map of moisture content.

20 Fluid was introduced into the sample by a hand-operated syringe connected by a flexible plastic tube to the vertical delivery tube machined from the plastic block. The desired amount of fluid was drawn into the syringe through a Y-shaped connection with one side open and the other closed; for delivery the other was opened and the first side closed. Generally, 25 mL of fluid was delivered in 1-2 seconds. The fluid supply and syringe operator were positioned 25 approximately 5 meters (15 ft) from the sample to avoid the strong magnetic field around the detector. The long flexible plastic delivery tube which connected the syringe to the sample was filled with fluid before the experiments were begun. The fluid used was an aqueous solution which contained 0.9 percent weight percent NaCl.

FIG. 3A is a contour plot of an absorbent structure 15 x 15 cm x 1.25cm (6 x 6 x 1/2 inch) obtained by magnetic resonance imaging. The contours represent various relative 30 moisture contents accumulated through the whole thickness at each position across the span after 25 mL of 0.9 weight percent saline solution has been introduced into the center. The view of FIG. 3A is down the delivery axis upon which the fluid insult has been delivered to the target area of the surface of the absorbent structure. FIG. 3A shows that the maximum relative 35 moisture content is located at the center of the insult point, which appears to be saturated. Moving across the structure outward from the center of the insult point, we then find successive contours representing progressively less relative moisture content as the distance

WO 96/12459

PCT/US95/13565

from the insult point is increased. This is precisely what would be expected from a rapid insult of fluid.

FIG. 8A shows profiles of relative moisture content at various positions along one side of a 15 x 15 cm x 1.25cm (6 x 6 x 1/2 inch) absorbent structure which has no patch. The horizontal axis represents distance in cm from the point of insult at 0. The vertical axis is arbitrary numerical units directly proportional to moisture. FIG. 8A shows a relatively high moisture content in the immediate area surrounding the insult site which then falls off with increasing distance from the insult site.

These results show that MRI is an effective analytical tool for the measurement of aqueous fluid distribution within an absorbent structure. When an absorbent structure is scanned repeatedly after a fluid insult at scan times which are short relative to the flow and ultimate disposition of the fluid insult, the movement over time of the fluid insult can be followed. This information can be used as the basis for inferences related to the various distribution mechanisms at work within the absorbent structure after insult by a fluid.

FIG. 8D shows the same view as FIG. 8A, but for an absorbent structure of this invention, which has a centrally located fluid-impermeable patch.

These FIG.s illustrate the distribution of 25 mL of 0.9 weight percent saline solution, with and without a fluid-impermeable patch. Without a patch, the fluid was distributed over a radially symmetrical area approximately 5 cm in diameter; the average fluid concentration in this region is approximately 450 units. With a 5 x 5 cm (2 x 2 inch) patch, the same amount of fluid is distributed over a toroidally-shaped region approximately 7 cm in diameter with a 2.5 cm diameter relatively dry region in the middle; the average fluid concentration in the ring of wetness was only about 150 units with peaks around 300 units.

The effect of two additional insults on each absorbent structure, up to a total of 75 mL in each, were also studied with this MRI method. Even after three insults to the absorbent structures, the sample with the patch does not have a "plateau" of saturation as extensive (around 450 units) as indicated for the control. This quantifies what a user of such a diaper would experience as a drier, more comfortable feel.

Examination of the final samples showed the absorbent structure without the patch to be wet on both its surfaces and that with the patch to have the fluid more uniformly distributed and much less wet on its surfaces. Both of these simulated diapers were constructed with a polypropylene nonwoven on the top (insulted) surface. An additional example utilizing no nonwoven material but with the patch showed intermediate performance. It is known that the nonwoven material is useful when compared to simple fluff. Therefore, we can conclude that the patch is of greater value than this liner, but the best performance was shown when both the liner and the patch were used.

WO 96/12459

PCT/US95/13565

WHAT IS CLAIMED IS:**1. An absorbent structure comprising:**

- (A) an absorbent layer having dimensions of length, width and thickness, the absorbent layer having at least an upper surface with dimensions of length and width, wherein the ratio of length to thickness is from 1 to 1000 and the ratio of width to thickness is from 1 to 500; and
(B) a fluid-impermeable patch centrally located adjacent to or covering a part of the upper surface of the absorbent layer, the patch having dimensions of length, width and thickness, the area of the patch being from 2 to 90 percent of the area of the upper surface of the absorbent layer.

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 9980 9985 9990 9995 9999

WO 96/12459

PCT/US95/13565

width and thickness, the area of the patch being from 2 to 90 percent of the area of the upper surface of the absorbent layer.

9. The absorbent structure of Claim 8 wherein the length of the absorbent layer is from 5 cm to 100 cm, the width of the absorbent layer is from 2 cm to 30 cm and the thickness of the absorbent layer is from 0.1 cm to 5 cm.

10. The absorbent structure of Claim 8 wherein the length of the fluid-impermeable patch is from 3 cm to 90 cm, the width of the fluid-impermeable patch is from 1 cm to 25 cm and the thickness of the fluid-impermeable patch is from 1 μm to 300 μm .

11. The absorbent structure of Claim 8 wherein the absorbent layer comprises one or more of fluff, superabsorbent polymer, cellulosic materials, modified cellulose, cellulose tissue, meltblown synthetic fibers, polyethylene, polypropylene, polyester, polyamide, copolymer of polyester or polyamide, open cell foam, and bicomponent fiber.

12. The absorbent structure of Claim 8 wherein the fluid-permeable layer comprises one or more of airlaid or meltblown synthetic fibers including rayon, polyester, polyethylene and polypropylene, and natural fibers including cotton and cellulose.

13. The absorbent structure of Claim 8 wherein the fluid-impermeable patch comprises one or more of airlaid or meltblown synthetic fibers including rayon, polyester, polyethylene and polypropylene, natural fibers including cotton and cellulose, a thermoplastic film or resin, tightly woven cloth and latex adhesive.

14. The absorbent structure of Claim 8 wherein the fluid-impermeable patch is produced by imprinting or embossing the absorbent structure with a plastic or resinous material.

15. The absorbent structure of Claim 8 wherein the fluid-impermeable patch absorbs or passes less than 5 percent of a fluid insult within 5 minutes of the onset of the insult.

16. A method for determining the location of aqueous fluid within an absorbent structure with the use of magnetic resonance imaging comprising the steps of:

- (A) performing a magnetic resonance imaging scan on the absorbent structure;
- (B) collecting and storing data from the magnetic resonance imaging scan;
- (C) visually displaying the data.

17. The method of Claim 16 wherein steps (A) and (B) are performed two or more times so that fluid flow with the absorbent structure may be observed.

WO 96/12459

PCT/US95/13563

1 / 10

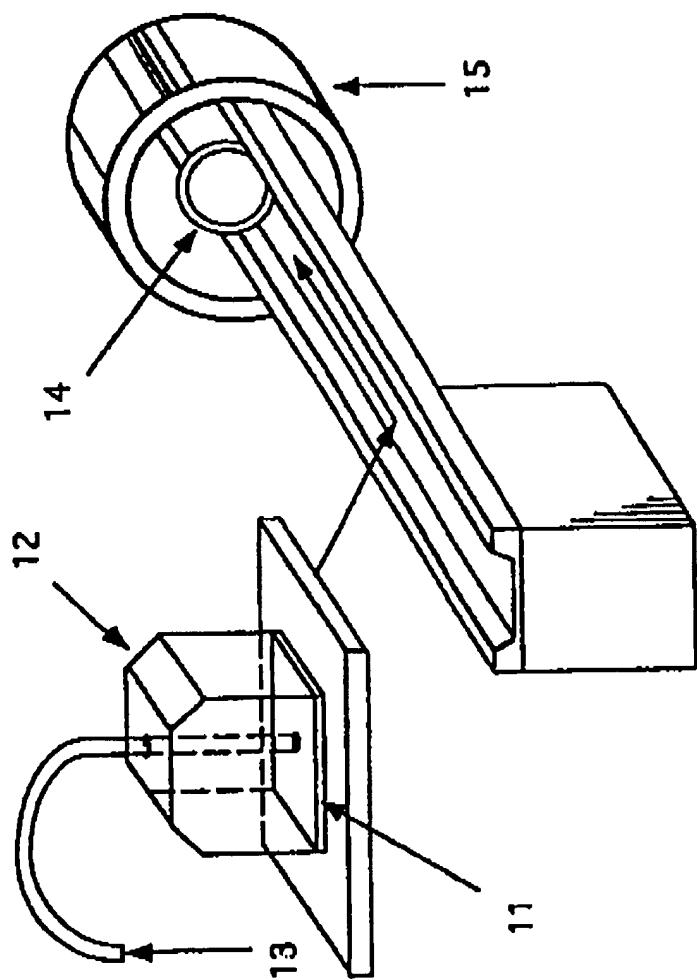


FIG. I

WO 96/12459

PCT/US95/13565

2 / 10

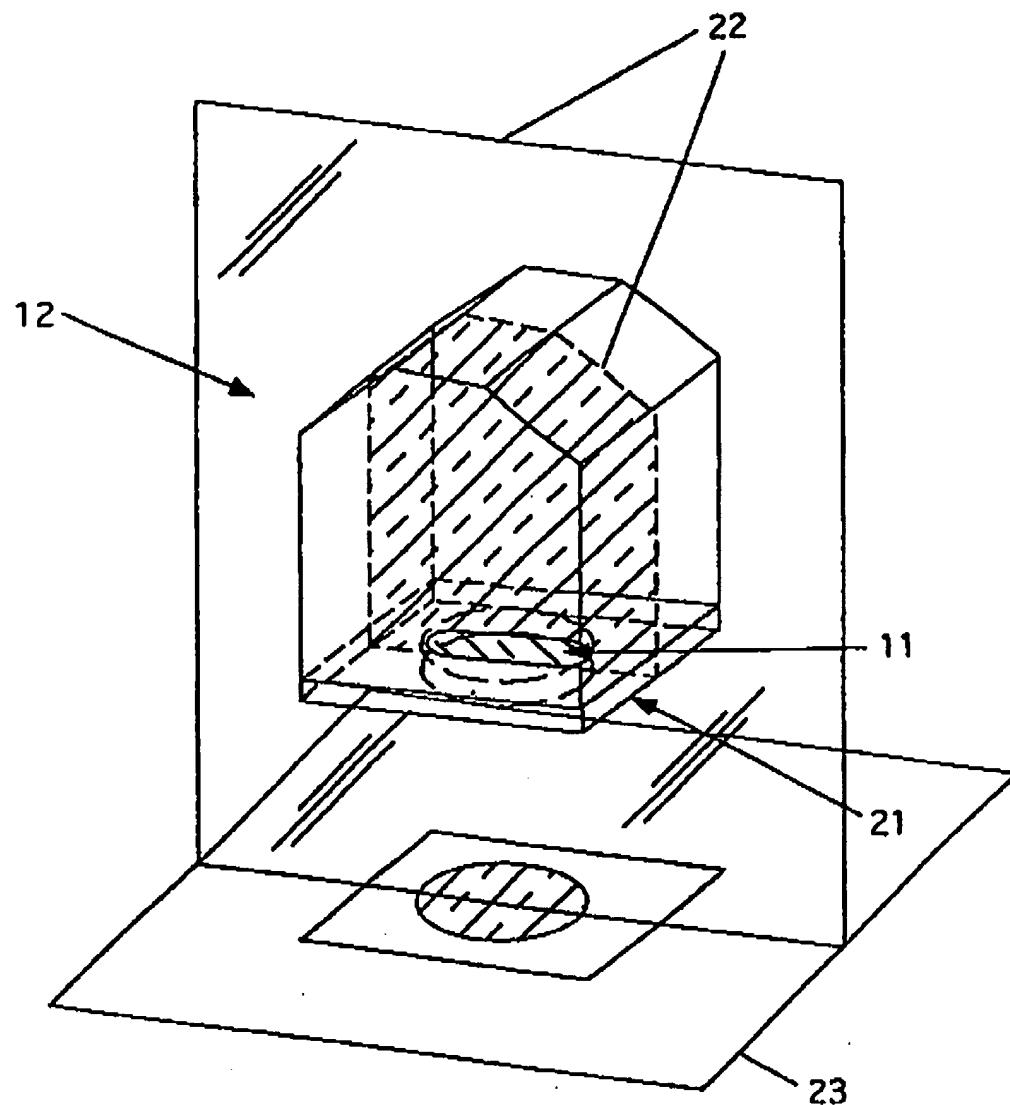


FIG. 2

WO 96/12459

PCT/US95/13565

8 / 10

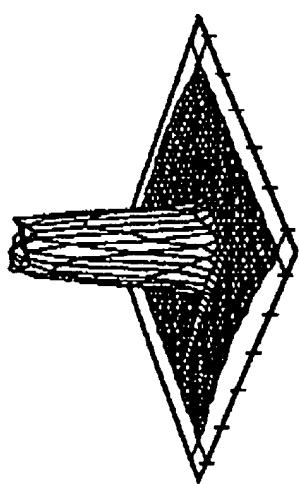


FIG. 3B

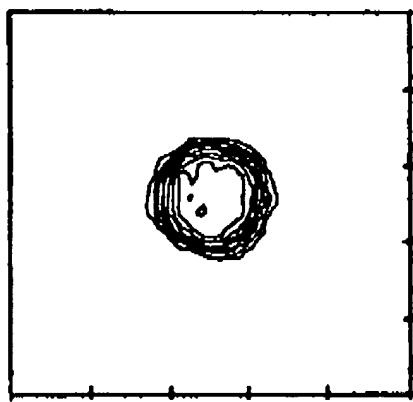


FIG. 3A

WO 96/12459

PCT/US95/13565

4 / 10

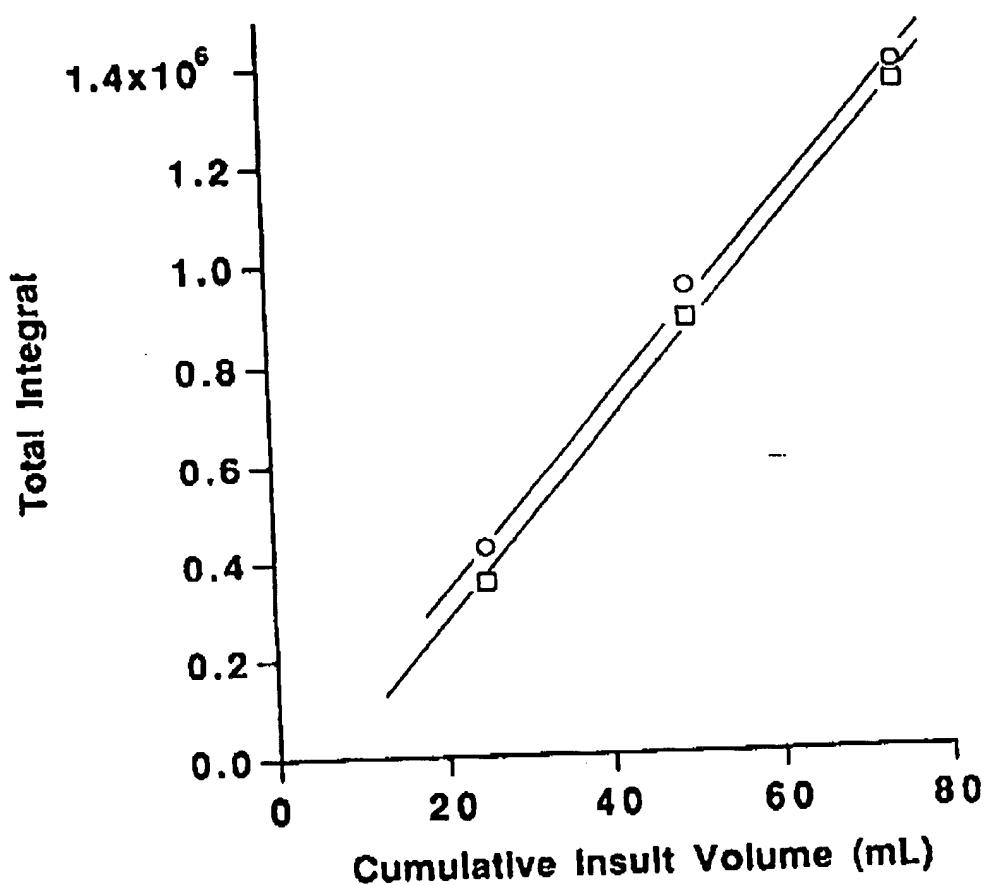


FIG. 4

WO 96/12459

PCT/US95/13565

5/10



Fig. 5C

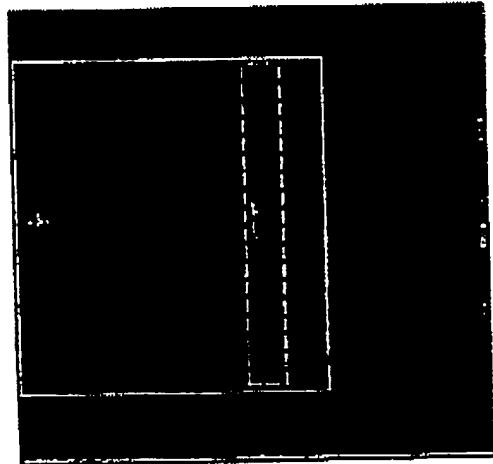


Fig. 5A

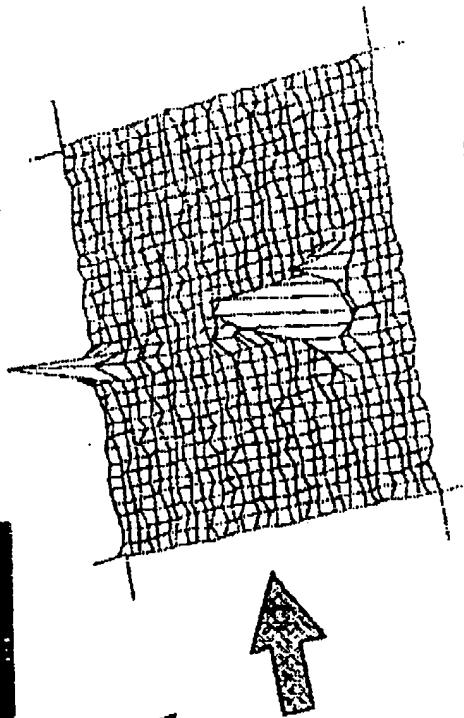


Fig. 5B

WO 96/12459

PCT/US95/13565.

6 / 10

FIG. 6A

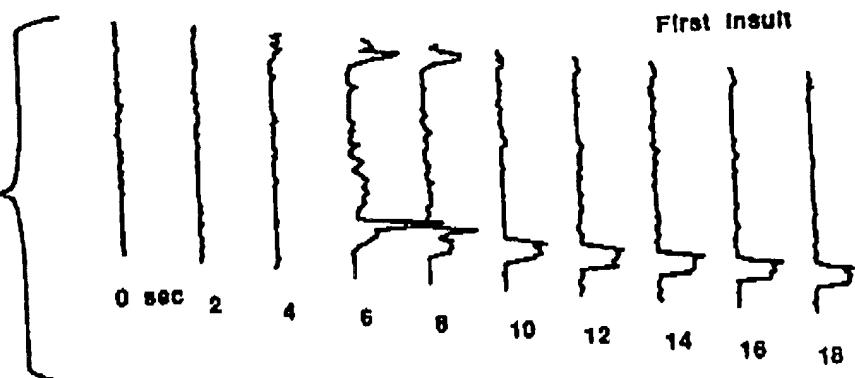


FIG. 6B

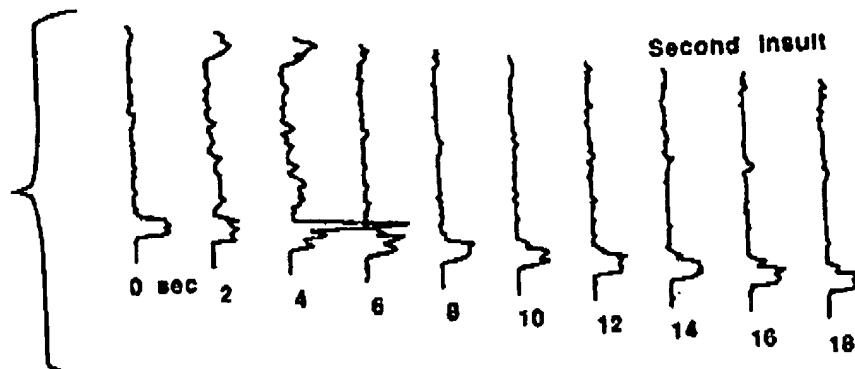
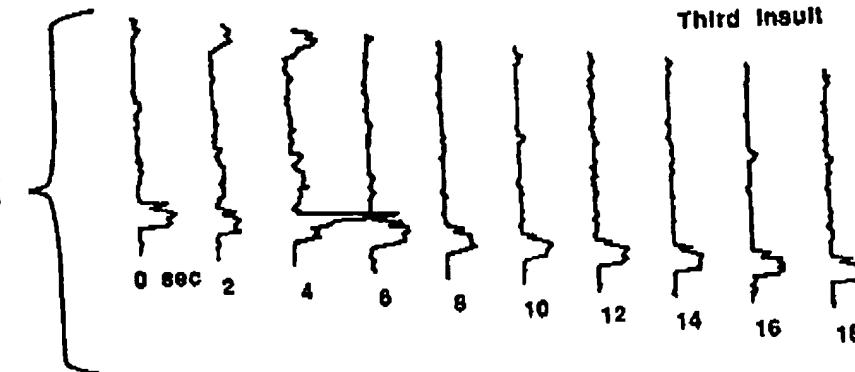


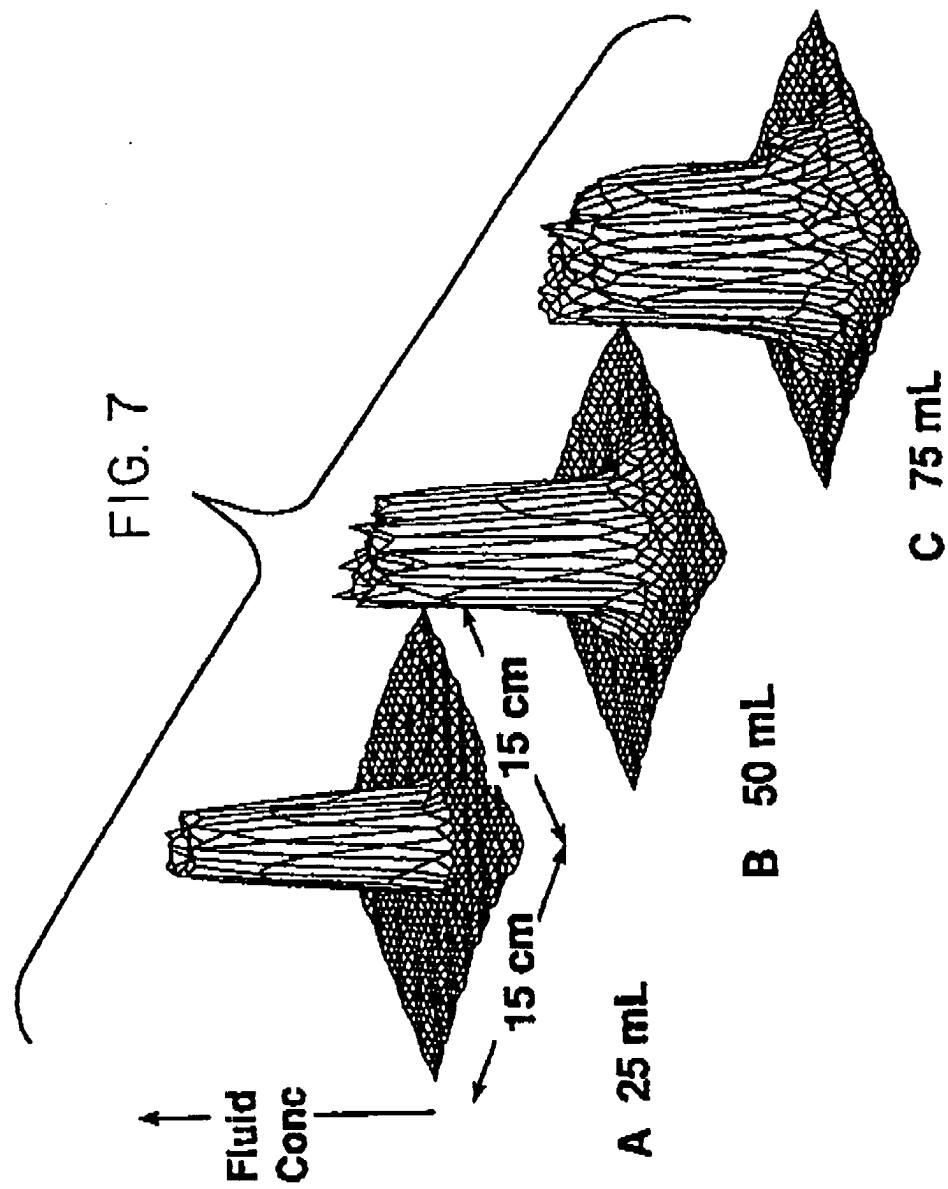
FIG. 6C



WO 96/12459

PCT/US95/13565

7 / 10



WO 96/12459

PCT/US95/13565

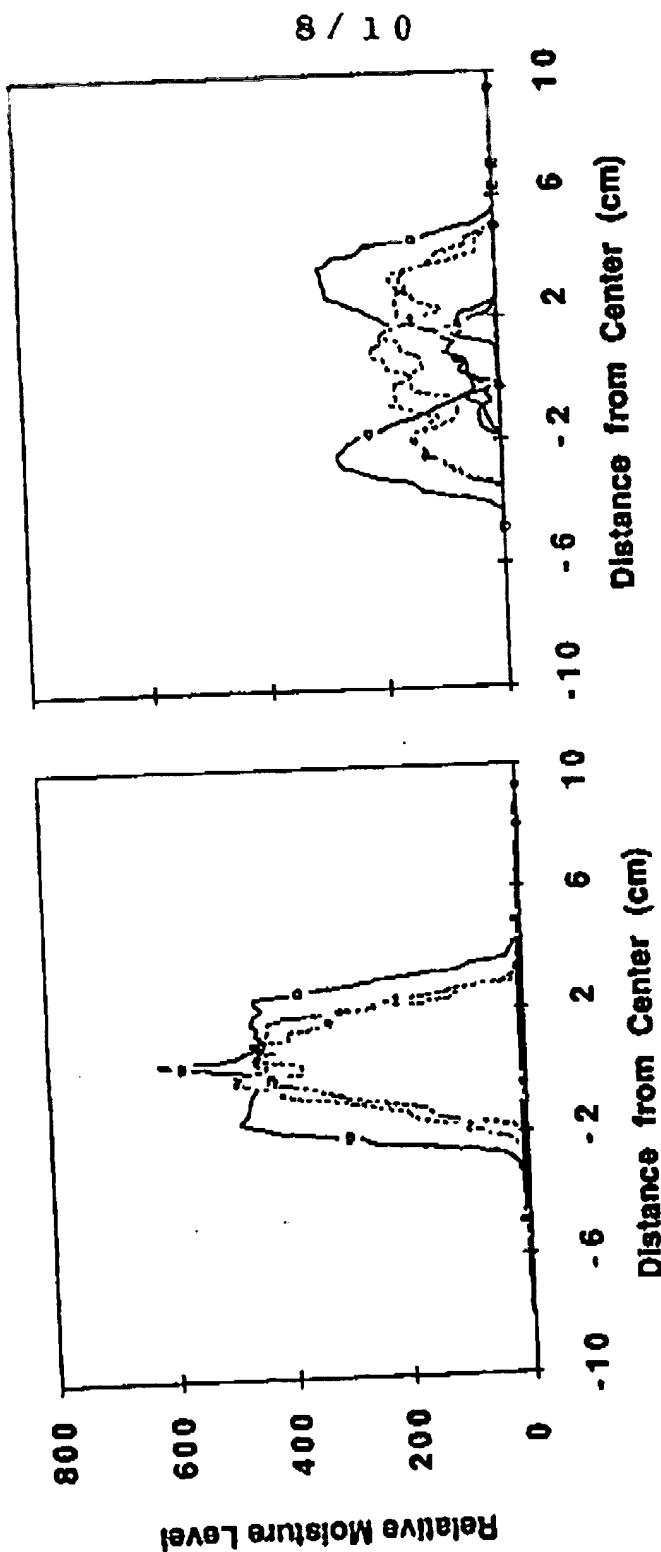


FIG. 8D

FIG. 8A

WO 96/12459

PCT/US95/13565

9 / 10

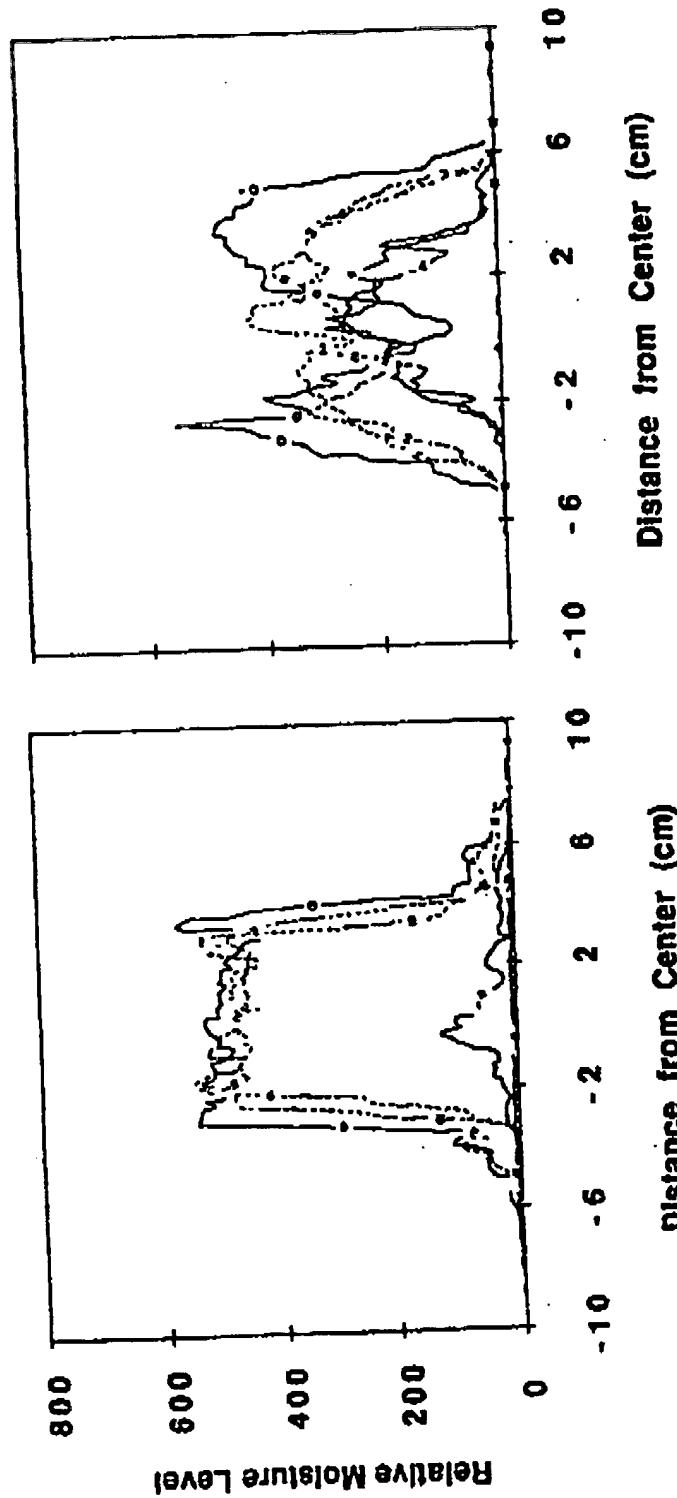
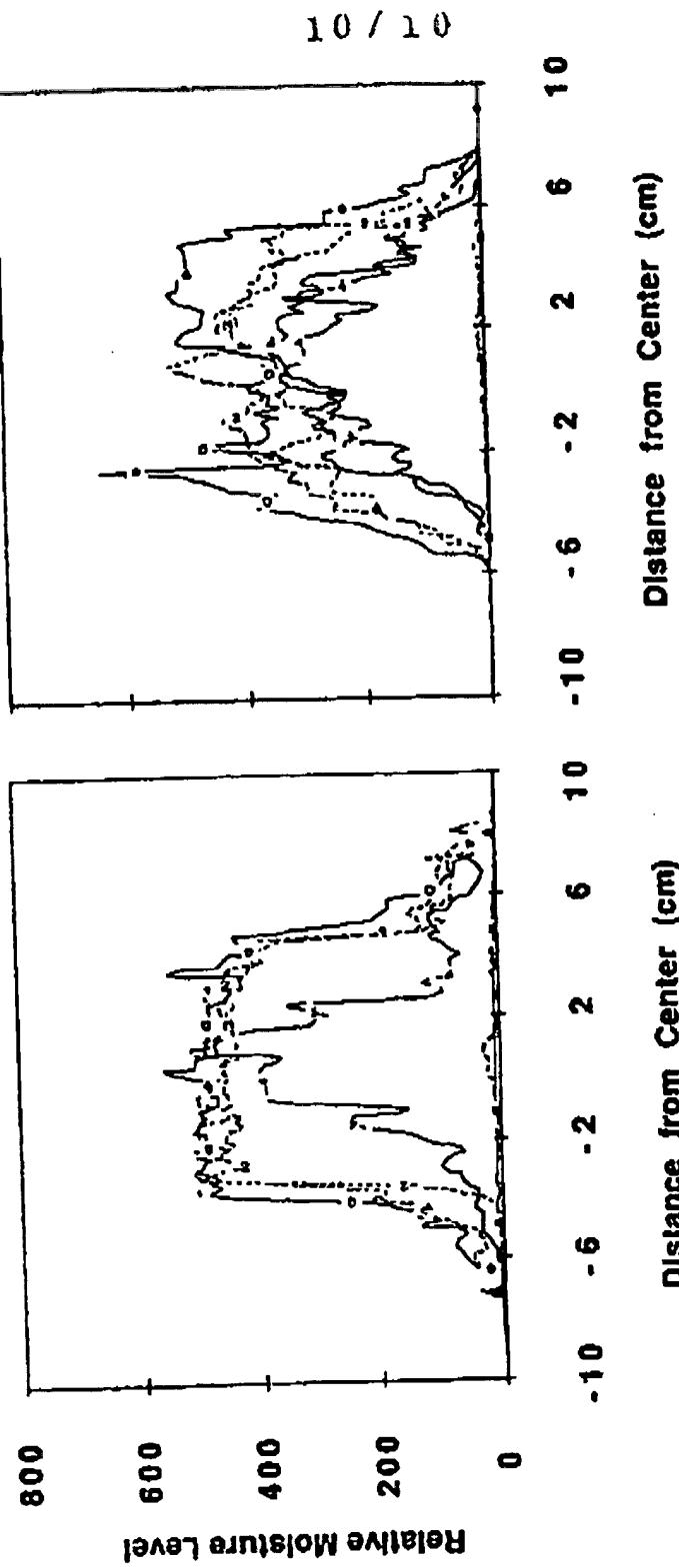


FIG. 8E

FIG. 8B

WO 96/12459

PCT/US95/13565



PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : A61F 13/15, G01R 33/44		A3	(11) International Publication Number: WO 96/12459
			(43) International Publication Date: 2 May 1996 (02.05.96)
(21) International Application Number: PCT/US95/13565		(81) Designated States: BR, CN, JP, KR, MX, SG. European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 11 October 1995 (11.10.95)			
(30) Priority Data: 08/327,945 24 October 1994 (24.10.94) US		Published <i>With international search report.</i>	
(71) Applicant: THE DOW CHEMICAL COMPANY (US/US); 2030 Dow Center, Abbott Road, Midland, MI 48640 (US).		(83) Date of publication of the international search report: 15 August 1996 (15.08.96)	
(72) Inventors: KAR, Kishore, K.; 4616 Oakridge Drive, Midland, MI 48640 (US). THOMAS, Robert, J.; 4907 Grandview Street, Midland, MI 48640 (US). STAPLES, Thomas, L.; 3212 Noeska Street, Midland, MI 48640 (US).			
(74) Agent: ROBERTS, John, H.; The Dow Chemical Company, Patent Dept., P.O. Box 1967, Midland, MI 48641-1967 (US).			

(54) Title: ABSORBENT STRUCTURE WITH FLUID-IMPERMEABLE PATCH

(57) Abstract

This invention relates to an absorbent structure, preferably containing superabsorbent polymer in an absorbent layer, and in particular, to a structure with a centrally located fluid-impermeable patch which redirects an insulting fluid around it in a manner to increase the overall containment efficiency of the structure. The absorbent structure of this invention is suitable for use in various absorbent articles and absorbent devices, such as, for example, disposable diapers, sanitary napkins, incontinent devices and garments, and training garments. The invention also relates to methods to determine the location of moisture within an absorbent structure and to study fluid flow and absorption of aqueous fluid by absorbent structures in real time.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GR	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NZ	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BH	Bahrain	HU	Hungary	NO	Norway
BY	Byrdines Peso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Beira	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russia Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SI	Slovenia
CH	Switzerland	LJ	Liechtenstein	SK	Slovakia
CI	Côte d'Ivoire	LK	Sri Lanka	SN	Senegal
CM	Cameroon	LU	Luxembourg	TD	Chad
CN	China	LV	Latvia	TG	Togo
CS	Czechoslovakia	MC	Monaco	TJ	Tajikistan
CZ	Czech Republic	MD	Republic of Moldova	TT	Trinidad and Tobago
DZ	Germany	MG	Madagascar	UA	Ukraine
DK	Denmark	ML	Mali	US	United States of America
ES	Spain	MN	Mongolia	UZ	Uzbekistan
FI	Finnland			VN	Viet Nam
FR	France				
GA	Gabon				

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/13565

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61F13/15 G01R33/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,A,20 29 766 (GEORGIA-PACIFIC) 23 December 1971 see page 4, line 32 - page 5, line 17 see page 8, line 1 - line 10; figure 2 ---	1-5, 7-13,15
X	US,A,4 778 459 (R.C.FUISZ) 18 October 1988 cited in the application see column 3, line 38 - line 49; figure 2 ---	1-5, 7-13,15
A	EP,A,0 139 351 (E.R.SQUIBB & SONS) 2 May 1985 see page 8, line 7 - page 9, line 11; figures 1,2 ---	
A	FR,A,2 515 029 (VEREINIGTE PAPIERWERKE) 29 April 1983 see page 4, line 25 - line 28 see page 5, line 19 - line 24; figure 3 ---	
	-/-	

Further documents are listed in continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *'A' document defining the general state of the art which is not considered to be of particular relevance
- *'E' earlier document but published on or after the international filing date
- *'L' document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *'O' document referring to an oral disclosure, use, exhibition or other means
- *'P' document published prior to the international filing date but later than the priority date claimed

*'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

*'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

*'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

*'A' document member of the same patent family

2

Date of the actual completion of the international search

Date of mailing of the international search report

07.06.96

13 March 1996

Authorized officer

NICE P.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/13565

C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 196 654 (NATIONAL STARCH AND CHEMICAL) 8 October 1986 see page 5, line 11 - line 23; figures 1A-2A -----	
2		

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

page 2 of 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/13565

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(3)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Subject No 1: Claims 1-15 An absorbent structure with a fluid-impermeable patch
Subject No 2: Claims 16-17 A method for determining the location of an aqueous fluid within an absorbent structure

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invoke payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-15

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int'l. Application No.
PCT/US 95/13565

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A-2029766	23-12-71	NONE		
US-A-4778459	18-10-88	FR-A-	2630385	27-10-89
		GB-A-	2217205	25-10-89
EP-A-0139351	02-05-85	AU-B-	569984	25-02-88
		AU-B-	3071984	24-01-85
		CA-A-	1226701	15-09-87
		JP-A-	60036049	25-02-85
		US-A-	4643726	17-02-87
FR-A-2515029	29-04-83	DE-A-	3142641	26-05-83
EP-A-0196654	08-10-86	US-A-	4627847	09-12-86
		AU-B-	565866	01-10-87
		CA-A-	1291325	29-10-91
		DE-A-	3688651	05-08-93
		DE-T-	3688651	14-10-93
		EP-A,B	0400694	05-12-90
		JP-C-	1863247	08-08-94
		JP-A-	61232846	17-10-86
		US-A-	4718898	12-01-88
		US-A-	4692161	08-09-87

Form PCT/ISA/210 (Patent family search) (July 1992)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
2 May 1996 (02.05.1996)

PCT

(10) International Publication Number
WO 96/12459 A3

(51) International Patent Classification: A61F 13/15. (74) Agent: ROBERTS, John, H.; The Dow Chemical Company, Patent Dept., P.O. Box 1967, Midland, MI 48641-1967 (US).

(21) International Application Number: PCT/US95/13565

(81) Designated States (national): BR, CN, JP, KR, MX, SG.

(22) International Filing Date: 11 October 1995 (11.10.1995)

(84) Designated States (regional): European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

(25) Filing Language: English

Published:

- With international search report.
- With amended claims.

(26) Publication Language: English

(88) Date of publication of the international search report:
15 August 1996

(71) Applicant: THE DOW CHEMICAL COMPANY

Date of publication of the amended claims: 12 April 2001

[US/US]; 2030 Dow Center, Abbott Road, Midland, MI

48640 (US).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(72) Inventors: KAR, Kishore, K.; 4616 Oakridge Drive, Midland, MI 48640 (US). THOMAS, Robert, J.; 4907 Grandview Street, Midland, MI 48640 (US). STAPLES, Thomas, L.; 3212 Noeske Street, Midland, MI 48640 (US).



WO 96/12459 A3

(54) Title: ABSORBENT STRUCTURE WITH FLUID-IMPERMEABLE PATCH

(57) Abstract: This invention relates to an absorbent structure, preferably containing superabsorbent polymer in an absorbent layer, and in particular, to a structure with a centrally located fluid-impermeable patch which redirects an insulting fluid around it in a manner to increase the overall containment efficiency of the structure. The absorbent structure of this invention is suitable for use in various absorbent articles and absorbent devices, such as, for example, disposable diapers, sanitary napkins, incontinent devices and garments, and training garments. The invention also relates to methods to determine the location of moisture within an absorbent structure and to study fluid flow and absorption of aqueous fluid by absorbent structures in real time.

WO 96/12459

PCT/US95/13565

AMENDED CLAIMS

[received by the International Bureau on 2 July 1996 (02.07.96);
 original claims 1 and 4-7 amended; original claims 8-17 cancelled;
 remaining claims unchanged (1 page)]

1. An absorbent structure consisting essentially of:
- (A) an absorbent layer having dimensions of length, width and thickness, the absorbent layer having at least an upper surface with dimensions of length and width, wherein the ratio of length to thickness is from 1 to 1000 and the ratio of width to thickness is from 1 to 500; and
 - (B) a fluid-impermeable patch
- said patch being characterized by: (1) being centrally located between the absorbent layer and an anticipated source of fluid insult; (2) having an area of from 2 to 90 percent of the area of the upper surface of the absorbent layer; and (3) absorbing or passing less than 5 percent of a fluid insult within 5 minutes of the insult.
2. The absorbent structure of Claim 1 wherein the length of the absorbent layer is from 5 cm to 100 cm, the width of the absorbent layer is from 2 cm to 30 cm and the thickness of the absorbent layer is from 0.1 cm to 5 cm.
3. The absorbent structure of Claim 1 wherein the length of the fluid-impermeable patch is from 3 cm to 90 cm, the width of the fluid-impermeable patch is from 1 cm to 25 cm and the thickness of the fluid-impermeable patch is from 1 μm to 300 μm .
4. The absorbent structure of Claim 1 wherein the absorbent layer is selected from the group consisting of fluff, superabsorbent polymer, cellulosic materials, modified cellulose, cellulose tissue, meltblown synthetic fibers, polyethylene, polypropylene, polyester, polyamide, copolymer of polyester or polyamide, open cell foam, bicomponent fiber and combinations thereof.
5. The absorbent structure of Claim 1 wherein the fluid-impermeable patch is selected from the group consisting of airlaid synthetic fibers, meltblown synthetic fibers, rayon, polyester, polyethylene, polypropylene, natural fibers, cotton, cellulose, thermoplastic film, thermoplastic resin, tightly woven cloth, latex adhesive and combinations thereof.
6. The absorbent structure of Claim 1 wherein the fluid-impermeable patch is produced by imprinting or embossing the absorbent structure with a material selected from the group consisting of plastic materials and resinous materials.
7. The absorbent structure of Claim 1 which further consists essentially of a fluid-permeable layer adjacent to the upper surface of the adsorbent layer.

35